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HEATING
BY
ARTIFICIAL MEANS

FOURTH EDITION, REVISED

KEITH

HEATING

BY

ARTIFICIAL MEANS.

BY

JAMES KEITH,

Gas, Hydraulic, Ventilating, and Heating Engineer,

LONDON, EDINBURGH, AND ARBROATH.

PRICE ONE SHILLING.

FOURTH EDITION—REVISED.

1884.

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HEATING.

THE proper heating of all buildings, public or private, in cold or damp weather, is a most important matter both as to health and comfort; but, generally speaking, our homes, places of meeting, and places of business are neither properly nor healthily heated, rather the reverse—and those places which are warmed, or said to be warmed, are very often done so imperfectly, injudiciously, and at a great comparative cost for fuel.

Let us glance for a moment at the various modes of Artificial Heating in use.

I.—ORDINARY OPEN FIRES.

This is the most common and oldest plan of heating, and it effects the purpose very well in small places or rooms, only it is expensive, and generally furnishes a deal of dust and smoke along with it.

The small amount of heat given off, for the great amount of fuel consumed, condemns this plan, however, from an economical point of view—though, owing to the open fire and chimney assisting ventilation very materially in small places, it is not so injurious to the health as some other modes hereafter mentioned.

Also, the *cheerful* appearance of an open fire often gives an *apparent* warmth to a place, which the existing temperature does not warrant.

Though it is thus pleasant to look at an open fire, it should always be borne in mind that the little heat which is got from it is got at a tremendous waste of fuel—the chimney getting the principal benefit—the *cheerful feeling* of warmth notwithstanding, it being remarked in passing that the *cheerful feeling* spoken of is simply imaginary; as people generally feel quite as cheerful in a room in summer when there are no fires as they do in winter with fires, it being *warmth* that is required, and not a *feeling* or *appearance only* of warmth.

Ordinary open fires are, however, only suitable for rooms or small places, as formerly stated: in large areas they are utterly useless for heating, and we must look for something else.

Dr. Arnott, in his well-known "Treatise on Warming and Ventilating," enumerates many evils which are more or less inseparable from open fires. Among these are "waste of fuel, unequal heating, a stratum of cold air near the floor, the production of dust and smoke, loss of time in attendance, and danger to person and property."

While on the subject of open fires, it may be mentioned that we have lately perfected an arrangement, called our Open Fire Hot Water Apparatus, which is of an ornamental character, and forms a complete and powerful hot water heating apparatus in itself, of any size, combining the ventilation and cheerfulness of the open fire with the healthy warmth and safety of hot water heating. This apparatus is illustrated and more fully described under Hot Water Heating further on.

II.—STOVES OR HOT AIR APPLIANCES.

Hot air, as supplied by the ordinary stoves in use, or through special hot air furnaces (for the *principle* is the same in both cases), is largely used for heating halls, vestibules, churches, and buildings of all sorts, and this plan of heating often does very well, plenty of heat, of a kind, generally being got, but at a great consumption of fuel.

Considerably better results, both as regards economy in fuel and amount of heat got, are obtained by this plan than by the open fires—only the heat so obtained is dryer, and much more injurious to health, owing to the overheating of the atmosphere by the contact of the very hot plates of the ordinary stove, or the passage of the air through the hot air furnace box or pipes.

For instance, if a room be *overheated* by a stove, or if a church be *overheated* by a hot air apparatus, the temperature being, say, *over* 60°, a nauseous, suffocating atmosphere will be felt on suddenly entering either the room or the church, and this feeling is quite correct, as places heated up to this temperature by hot air only, in this manner, are simply being heated by, as it were, *burnt* air or a form of gas, in a great measure, which, being breathed over and over again by people in these places, makes the whole style of heating most injurious, unhealthy, and unsatisfactory from every point of view.

The above remarks refer more particularly to coal, coke, or wood burning stoves or hot air furnaces. In regard to *gas* stoves for warming, they do very well on a small scale for heating any small and well ventilated place, such as open shops. vestibules, and offices, but in sleeping or living rooms they are very prejudicial to health, as, generally speaking, and unless specially provided against, the products of combustion (which are highly poisonous) are not carried off from these stoves, so that people living or sleeping in these rooms have to breathe the bad gases, which is, of course, very dangerous. Gas stoves for warming are mere toys at the best, as well as most expensive to keep going, and are quite unsuitable for large places.

These remarks of course do not apply to gas cooking stoves.

which in many cases, with a cheap low standard illuminating gas, give excellent results.

The danger arising from open fires, and especially from stoves and hot air furnaces, is very great, as is daily shown by the destruction of valuable buildings, such as dwelling-houses, mansions, churches, museums, and other public buildings by fire, which, in the majority of cases, is traceable to these sources; the only really *safe* mode of heating these places being by Hot Water Appliances, as explained further on.

III.—STEAM-HEATING.

There are various modes of heating by steam, viz., what are called *Low* Pressure, or the gravity system, *High* Pressure, or the Expansive System, and heating by Exhaust Steam.

Low Pressure steam heating, or the gravity system, is the heating by steam at a pressure varying from 5 lbs. to 10 lbs. the square inch. This is an admirable plan for heating large ranges of warehouses, public buildings, and offices, and it consists in placing a powerful and rapid heating boiler preferably composed principally of tubes, in the basement under the building to be heated: from this boiler, malleable iron pipes are run up through the rooms, or other places requiring warmth, where they terminate in neat box coils of pipes under cast-iron fret-work, or vertical pipe or other radiator, according to taste and style of building—the return pipes being carried back again to basement, where they are connected to the boiler in a peculiar manner direct, if the boiler is placed low enough, or to a curiously constructed return steam trap, from which the condensed steam is again returned to boiler without waste or exhaust.

This plan of heating, to be successful, has to be most carefully fitted by experienced hands, and a basement floor is indispensable, unless the return trap mentioned is used; also it requires considerable attention in working to keep up a good and uniform result. See other remarks following, on High Pressure Steam Heating, as to the heat and its application, which apply equally to this mode.

High Pressure Steam Heating is the heating by *live* steam, at a pressure from over 10 lbs. to, say, 50 lbs. or over, to the square inch, from any ordinary existing boiler, applied through pipes or radiators in a similar manner.

This plan of heating is almost universally adopted for workshops, mills, and factories, and seeing in these places live steam is generally at hand, it is the quickest and most powerful plan that could be adopted in the circumstances, though it is by no means the healthiest or most economical. By this system the condensed steam can either be returned to the boiler through special return steam traps, or liberated into the atmosphere through ordinary steam traps, when the steam is used expansively.

All steam heating, however, being of a live, scorching nature, has a great tendency to overheat the air, in ordinary buildings, as in the hot air plans spoken of, unless special and thorough mechanical ventilating arrangements are introduced, so as to pass or draw the air so rapidly over the pipes, &c., as to prevent overheating; therefore the same objection on the score of health applies equally to it.

For *continuous* and very *high* temperatures, however, say of 150° or over—for drying or other manufacturing purposes, or for the heating of Turkish baths, hot rooms, &c.—steam heat is without doubt the *best* under all circumstances, if well arranged and fitted. Exhaust steam from a high pressure steam engine can also be most advantageously employed for heating; the steam being led through large pipes suitable, or into space, in the shape of sectional coils of large area, so as not to put any undue drag or back pressure on the engine. This plan, when properly arranged and fitted by skilled hands, gives excellent results, more especially for drying rooms, stoves, &c., and for commercial purposes on a big scale.

Steam Heating is most effectual when applied on the *direct-indirect* or the *indirect* principle of heating buildings, &c.: when applied on the *direct* principle it overheats the air too much, as already fully shown. It may be explained here that *direct* heating means the heating of the air contained in the rooms or places to be heated only, by the placing of the pipes, coils, or radiators directly in these places, above the floor, without introducing fresh air from the outside either under, or past, or through, the said pipes or coils.

Direct-indirect heating consists in placing pipes, coils, or radiators in the rooms or places to be heated, to heat the air contained in these places in the same way as by *direct* heating, only in addition, fresh pure air is admitted under, or through between, or past these coils or radiators from the outside, which fresh air is only, of course, heated *once*, as it passes in, while the air of the room is heated over and over again by direct radiation from the coils themselves, and by the consequent circulation of the air contained in the room.

Indirect heating again consists in placing all the heating pipes or coils below the floor level of the rooms or places to be heated, or into a special heating chamber or chambers, as the case may be, and conducting air from the outside through these chambers, and passing it warmed through separate branch shafts or channels into the places to be heated, so that by this system the air is only heated once as it passes through the heating chamber or chambers, which may be placed in the lower floor, and, if necessary, a *considerable distance* away from the parts to be heated.

Both the *direct-indirect* and the *indirect* systems of heating cannot be successfully applied unless with the aid of motive power or a powerful chimney to keep up a sure and constant blast or exhaust, as explained in more detail under 'Hot Water Heating.' For the simple warming of conservatories, forcing pits, and vineries steam heating is most unsuitable, as it is liable, through slight inattention at any time, to be either too hot or too cold all of a sudden: these places require a continuous and mild temperature night and day.

The heating of large bodies of water by steam is most expensive, and should never be thought of unless for special *boiling* purposes, or under peculiar circumstances, or for the heating of salt water, or when the result cannot possibly be attained by *Hot Water Circulation*, which is certainly by far the best and most economical plan.

Steam Heating, unless by the exhaust steam system specially applied, is not economical so far as fuel is concerned, and cannot be compared on this score with 'Hot Water Heating,' as explained further on.

It will thus be seen that Steam Heating has its advantages as well as its disadvantages for various kinds of buildings: further, it is not advisable or suitable for the heating of churches, schools, mansions, private dwellings, and buildings of like nature, owing to the above-mentioned objections, as well as others, such as the considerable noise and rattling often heard in the pipes from the unavoidable mixing of the steam and water, which the very best fitting cannot at all times overcome, together with the danger inseparably connected with steam appliances in the hands of unskilled attendants.

IV.—HIGH PRESSURE HOT WATER OR 'PERKIN'S' SYSTEM.

This is a plan of heating adopted many years ago in England and America, and which has again appeared in this country of late under the designation of the small pipe system.

It consists in, as it were, hermetically sealing up a quantity of water in a range of strong malleable iron pipes of small area; these pipes are dispersed through a building in any convenient form to give heating surface, and they terminate in a coil of continuous pipe, lining the inside of a furnace in the lowest part of the building.

A very high scorching temperature can be raised on these pipes, and, seeing that they are thoroughly closed up, no evaporation or waste of water can take place, and there being no steam space left in the pipes, no steam can be formed, the excessive expansion, and consequent high temperature of the water, being provided against by the sheer strength of the pipes themselves, and various rods and other appliances.

This plan, or several modifications of it, works well enough (though it is comparatively expensive for fuel), as long as everything keeps right and tight; but should any leak occur, which is not at all unlikely, as there is a constant and excessive strain on the pipes and joints when in use, accidents may occur.

For instance, by the smallest possible leak, a steam space is formed in upper parts of pipes, where a steam pressure may be *generated, unknowingly,* fit to do serious damage. Also, by overheating (the apparatus having, say, very little to do), hydrogen may be formed in the small pipes in the fire, when red hot, by the decomposition of the water. When this happens, an explosion is almost certain, and its consequences much more serious.

From the above and other reasons, such as the liability of these very small pipes to freeze in winter, when not in use for a day or so, the rusting up of the pipes solid, if not carefully and periodically cleaned or scoured out (there being *so very little* water in the pipes), the impossibility of shutting off different sections of the buildings heated and still leaving part heated, the scorching and unhealthy nature of the heat given off, together with the large consumption of fuel necessary to give anything like good results, this style of heating is most objectionable, and not at all advisable for introduction generally into private use.

On the whole, therefore, as there is really no great benefit to be gained by this high-pressure mode of heating, but rather the reverse, seeing we can give infinitely greater advantages by Low Pressure Hot Water Heating (by circulation) with far less fuel consumpt, and no risk, it is surprising that the system should be again revived in this country, when the accidents indicated (and these are not hypothetical, as numerous cases have come under the writer's notice) are likely to occur at any moment.

These remarks were written and published in the first edition of this pamphlet years ago. They are now republished in the present issue in exactly the same words as they first appeared, and we think the truth of the statements they contain is amply corroborated by the following extract, which appeared in the Edinburgh *Evening News*, on Wednesday, 29th August 1883—the name of the maker being withheld :

'EXPLOSION OF A HEATING APPARATUS IN GLASGOW.—'EDINBURGH MAN INJURED.—Yesterday afternoon a heating 'apparatus exploded in the new Burgh Chambers, Stanley 'Street, Kinning Park, Glasgow. The new Burgh Buildings 'are scarcely completed yet, and a number of tradesmen are 'still employed about them. In the portion of the new 'edifice intended for the police an apparatus was fitted up 'for the purpose of heating the office and the cells, the maker 'being from Edinburgh. The apparatus was being tested 'yesterday, and the maker was present superintending operations. He was the only occupant of the room at the time the 'test was being made. The apparatus having been filled with 'water, a fire was lighted, and as there was nothing indicative 'of danger he sat down to read a newspaper. But about three-quarters of an hour after the fire had been lighted a violent 'explosion occurred, the cause of it being the bursting of one of 'the bends of that portion of the apparatus designated "the 'worm." The apartment was immediately flooded with water, 'and several panes of glass were smashed, while the maker was 'thrown violently against a wooden counter immediately in front 'of the apparatus, and a piece of the grate struck him in the 'right leg, causing a compound fracture between the knee and 'the ankle. He was also burned on the left hand. He was 'conveyed to the Royal Infirmary. The walls of the apartment 'in which the explosion occurred were much damaged.'

[The above-named apparatus being on 'Perkin's' or the small pipe, high-pressure, system].

V.—HOT WATER HEATING

BY THE CIRCULATION OF HOT WATER.

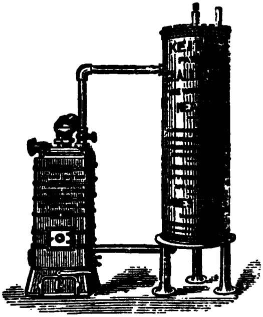
Of all the foregoing methods, the system of hot water heating by circulation only, is certainly by far the simplest, safest, and best, in most cases, when properly applied, and taken full advantage of.

Unfortunately in many cases in our experience heating by hot water turns out anything but succcessful, chiefly owing to the imperfect knowledge of the first principle of circulation by inexperienced hot water engineers, and consequent bad planning and fitting.

The reason of these failures is obvious. Hot water circulation, though very simple in principle and action, has certain clear and distinct rules, which must be most carefully and rigidly observed in all cases and under all conditions. If these rules be strictly kept in view, and the proper and most improved appliances used, success is sure, whereas if, instead, these rules are neglected or ignored through imperfect knowlege, failure will be the result.

We will endeavour to make clear to our readers the principle of hot water circulation, and how it should be applied through special and various appliances for heating purposes, so as to ensure success; our own knowledge on this subject, as well as on that of steam-heating, having been gained by hard study and practical experience, both in this country and America.

The principle of hot water circulation is very simple. Hot water, being much lighter than cold, always inclines to rise above the cold water; thus if a boiler be connected by, say, two pipes to a water cistern or cylinder, having its top open to the atmosphere, placed above, or alongside the boiler, or away from it even a considerable distance, or in the manner shown in illustration, the whole being filled with water; on a fire being lighted inside the



boiler, a heat is raised on the water surrounding the fire; so that the heated water rises by the top pipe into cistern or cylinder, the cold water returning by lower pipe to the boiler, again to get heated in turn, and thus it continues to *flow* up from boiler to cistern, and *return* down from cistern to boiler, until the whole water in the cistern is hot.

This illustration explains the whole system of hot water circulation, and though necessarily the simplest form possible, still these few rules must be always kept in view and faithfully carried out, even in the most varied and complicated forms of the many hot water apparatus and plans necessarily introduced to suit various conditions and requirements.

It will thus be seen that in a building heated by hot water, the boiler must be the very lowest part of the whole arrangement, the pipes (*flow* and *return*, as they are called) ascending from it to all parts of the building, to a given highest point, which should be open, to allow for expansion and evaporation; this gives a free and easy circulation to the water, and ensures as much safety in the working, as in the case of an ordinary kettle boiling with the lid off.

As already indicated, though a great deal depends on the proper fitting up of the pipes, coils, or other radiating surfaces used in the best hot water plans, together with the sizes of pipes and their proper connection to and distribution from the boiler, still, the most important thing of all, to ensure plenty of heat with economy in fuel, is a *proper* and *rapidly circulating* boiler.

The boiler, in fact, is the mainspring of the whole arrangement, as however well the pipes and apparatus are fitted up, if the boiler be not constructed on the most improved principle, to give quick circulation with small fuel consumption, the whole affair is generally most unsatisfactory, and expensive to keep going.

There are many forms of boilers in use, the most common being the saddle boiler, which requires to be set in, and built round with brickwork. There are also various forms and modifications of these saddle boilers, some in the form of a cross, others with shelves, flues, and cross-tubes through them, and so on; all these forms and modifications being considered improvements, to break up the water and present more heating surface to the fire. There are also the upright ring shell boilers, standing either with or without brickwork, the fire being placed inside of them, with direct flue through the top to chimney.

These and other forms of boilers of like nature are what we call "*slow circulation*" boilers, that is to say, they are simply, as it were, a continuation of the flow and return pipes into the furnace, which the fires act upon; and there being generally in all these boilers a *large body* of water, it is kept moving slowly round and round the whole range of pipes and through the boiler in a mass, without there being any extra or excessive circulation *within* the boiler itself, independent of the pipes, to cause *rapid* movement, and consequent quick heating, through the whole system.

This is the weak point of all these "*slow circulating*," or built in, boilers, and they are only really serviceable where coal is plentiful and consumption of fuel no great object. In fact, those in the trade, both in this country and America, who know better, dub all these boilers and forms thereof "*Fuel Devourers*," which is certainly a most appropriate term when comparing them with other new and improved boilers, which entirely supersede them, both as rapid heaters and fuel savers.

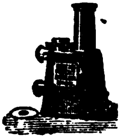
To make hot water heating more popular, effective, and economical, a powerful form of boiler is essential, with *internal circulation*, and which requires no building work around it in the shape of flues, &c., to soot up, weaken the draught, and absorb a great proportion of the heat.

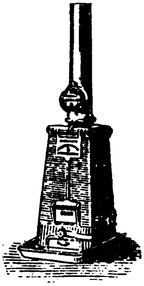
Various boilers on this internal circulating principle have also been made, such as boilers with a series of disjointed shelves, connected top and bottom to each other in layers, one above the other; slanting tubular boilers, &c., &c., all of which have had many objections which have prevented them from coming into more general use, such as their sooting and clogging up in the shelves or flues, loss of heat when rested down, by not having sufficient heating surface exposed to the action of the fire at rest, during night, &c., &c.

In order to overcome these many serious objections, and to gain all the advantages spoken of and accruing from the principle of Internal Circulation, we, some years ago, after careful experiments extending over years of practice, brought out an entirely new form of boilers, which we have been steadily improving and perfecting ever since, and which fully meet the requirements and overcome the objections mentioned above.

The accompanying illustrations show some of the smaller forms, or the 'C' sizes, which are the most compact and perfect small hot water Boilers in use, and the price of the smallest size is £2 10s, which heats 50 feet of 4-inch pipe, the second size, to heat 100 feet of 4-inch pipe, £5 10s, and the third size to heat 300 feet of 4-inch pipe, £12 10s; these boilers are capable of holding a comparatively large body of fuel, which can be either coal or coke, and one fire can be made to last from 10 to 12 hours, or longer, if necessary.

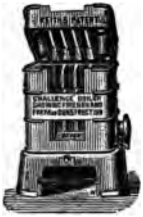
It will be observed that each boiler has a separate firing door, cleaning or clinker door, and dumping grate bar, and every possible arrangement necessary for regulating the fire, consuming the smoke and making the attention easy. These Patent Boilers can also be galvanised if necessary at an extra cost, to prevent discolorization of the water by rust, when used for heating water for washing or other purposes.

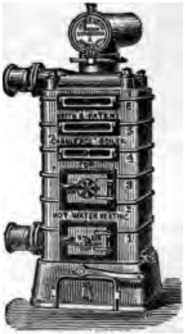




Our Patent Sectional 'Challenge' Boilers again are constructed of sections placed one above another in such a manner as to give about ten times the heating surface of ordinary saddle boilers, and are made in sizes, capable of heating, under ordinary circumstances, from, say, 500 feet up to 10,000 feet of 4-inch pipe: and the prices range from £16 10s upwards.

The following illustrations explain the exterior and interior construction. It will be observed that the heating surface is very great, and directly over the fire, even while rested; and, with the same fire grate surface, the power of each Boiler can be increased or decreased by adding to or deducting from the number of Sections; also the fire box can be increased to any desired depth, by the addition of ring sections, the firing door being moved higher up to allow for a larger body of fuel to be filled in for stove or night work; a cleaning door being provided in the front, level with fire bars, for taking out clinkers, &c.





The larger sizes of the 'Challenge' Boiler, even though they constitute by far the largest and most powerful single hot water *boilers ever made* (the largest size being in actual use heating two miles of 4-inch pipe, with only a 30-inch square, fire grate surface), occupy comparatively very little floor space and the boilers being made and sent out in sections carefully faced at the joints by special machinery, to fit each other accurately, the carriage can be most easily effected even to isolated places, and the pieces can be handled with ease through narrow doorways, and in the most confined situations.

The 'Challenge' Boilers are specially suited for the economical burning of coke, wood, or anthracite coal as fuel; and all parts can be readily got at to examine or clean when necessary.

All these new boilers, internally and externally, are quite different in principle and construction from any other existing boilers; owing to their peculiar construction, and the small body of water contained in the boilers at one time, an excessive and internal circulation is caused through every part of the boilers themselves, which prevents sediment and makes them most powerful circulators; they hold a deal of fuel at one time, thus require little attention, while at the same time the whole heating surface is directly exposed to the full force of the fire when rested down.

All the boilers stand complete in themselves; they require no brick-setting or building work round them, and, being wholly 'water-jacketted,' or surrounded with water on the outside, there is not the slightest risk from fire by their use, as there is from the outside brick flues of the ordinary built-in boilers. They can be set down anywhere with perfect safety, and even the larger sizes can be erected complete in a few hours.

If necessary, the boilers can be covered on the outside by non-conducting cement, or built round with brick work, to retain the heat when placed outside, or in exposed situations.

In our boilers, the draught is all upward, and a few feet of a metal smoke pipe, carried straight up, forms (even for the largest sizes) a good chimney of itself, giving a strong draught. The boilers can also be connected to any ordinary brick or other chimney by our air register smoke pipe connections, as shown in illustrations, which give facilities not only for regulating the fire and consuming the smoke, but also for ventilating the apartments in which boilers may be placed.

On test, and from ample experience, we find that the ordinary saddle or built in "*slow-circulation*" boilers already described, having the same fire grate surface, require about four times the amount of fuel, or 300 per cent. *more* fuel, to do the same work, and four times the length of time in which to do it, that our boilers require.

Keith's Patent Boilers having been in successful use now for years, both in this country and abroad, we have no hesitation in recommending them as being the best, most powerful, and most economical boilers made.

We need only mention the great and many advantages possessed by hot-water heating for horticultural purposes, even with the expensive old-fashioned 'slow-circulation' built-in boiler, over all other systems, some of these advantages being—

The entire freedom from bad gases, dust and smoke, so frequent by the old flue system—

The consequent saving of valuable plants that would otherwise be lost—

The small amount of attendance required—

The moist, mild, and healthy summer heat procured—

The safety and freedom from risk by fire—

The great economy in fuel.

Our boilers being specially designed for rapid and steady warming in green-houses, &c., increase the above-named *advantages to a great* extent, and, owing to their many recommendations already described, we can strongly recommend them for general use.

The warmth got by hot water appliances, as already indicated, is quite different from that got by open fires, stoves, or hot-air apparatus and steam pipes, being of a mild and continuous nature, resembling summer heat, the heating surface of the pipes used never exceeding the temperature of boiling water.

Thus it will be seen that hot-water heating is the only healthy heat obtainable by artificial means ; the air being simply *warmed* without being *scorched* ; it is consequently the only heat advisable for introduction, wherever health is a consideration—such as churches, halls, mansions, schools, private dwellings, hydropathic establishments, and buildings of this class.

This method of heating, when properly and efficiently applied, as compared with the other modes enumerated, is also the most economical, so far as fuel is concerned, for private use.

In heating hotels and mansions or dwelling-houses, &c., however, open fires being often preferred in sitting rooms, on account of their cheerful appearance and the sure ventilation afforded by their use, a combination of the open fire, together with hot-water heating, is generally advisable ; thus, by having the entrance hall, public rooms, and corridors in lower part of the house properly heated by hot water pipes, coils, or other ornamental appliances, pure air being drawn in underneath or past these from the outside, to keep up the supply of fresh air and to keep the atmosphere in the house sweet, with small open fires where desirable, the whole house is kept at a mild, equable, and healthy temperature by the ascension and circulation of the heated air from below, while ventilation is assured by the small open fires, care, of course, being taken to keep doors of rooms above as much open as possible, to facilitate the equal diffusion of the warm air, this being *direct-indirect* heating.

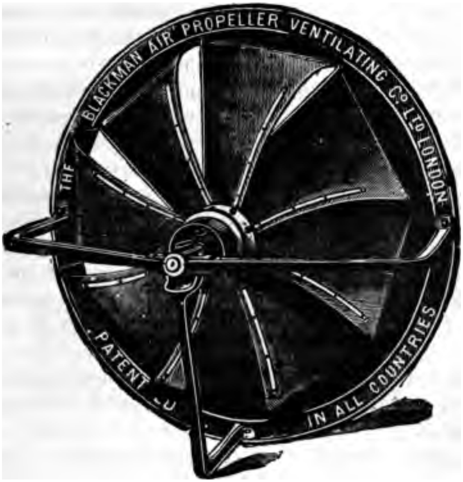
This plan can be further extended where required, as in the case of very large mansions, public institutions, and buildings, &c., by the introduction of numerous coils of pipes, placed in a closed non-conducting chamber, running the whole length, in ceiling of basement floor, as much as possible directly under main halls or corridors of floors above ; shafts being carried upwards in various ways, from this heated chamber, through all parts of the building.

Pure air being continuously drawn from the outside, at the lower extremity of heated chamber, consequently at a lower level, and heated in its passage over the hot pipes, is then passed by means of the shafts spoken of, through the whole place ; movable gratings being placed directly over main chamber, in halls, corridors, &c., and on the branch shafts wherever desirable, to regulate the supply of warm air. This is '*indirect*' heating.

This arrangement, however, can only be advised on a large scale, and to be continuously successful and satisfactory, either motive power is required to drive a silent blowing or exhaust fan, or a constant exhaust must be kept up outwards, by the aid of a tall and powerful chimney specially provided, so as to keep up a constant and sure inward current of pure, cold air upwards through heating chamber mentioned, to be warmed and passed through the house, in order to ensure satisfactory results in all states of the outside atmosphere, as air will not move unless impelled ; and in some states of the atmosphere nothing will move it, unless a strong blast or exhaust obtained in the manner stated ; also the heating pipe chamber and horizontal and upright shafts in connection must be kept perfectly clean and free from dust or refuse, to give the best results.

It has very justly been said that 'ventilation consists in *getting rid of all vitiated* air and replacing it by fresh air,' and so by this excellent, though elaborate mode, a constan current of pure, warm air is diffused throughout the entir building, and though the temperature be ever so high, n closeness or stuffiness in the atmosphere is experienced.

In the plans mentioned, 'Heating' and 'Ventilation' ar combined ; we find from experience, however, though thi arrangement appears perfect in theory, that in practice it is nc generally so, except, as we have already stated, on a very larg scale, as, to be successful, it must not be dependent on chanc wind, or temperature ; but the inward and outward ventilatio must be *constant*, *direct*, and *certain*, which can only be obtaine by the Fans or large chimney working in connection, as we hav described.


THE BLACKMAN AIR PROPELLER VENTILATING Co LTD LONDON
PATENT D IN ALL COUNTRIES

For epidemic and other hospitals, and in the case of pris large public institutions, national buildings, &c., 'Heating' and 'Ventilation' must be combined, in the manner already indicated, either by the '*direct-indirect*' or the '*indirect*' system, but in most cases special applications must be arranged to suit the special circumstances and situations.

In such cases we prefer to use silent Fans or 'Propellers' on the exhaust principle for moving the air, as we find from experience that this method is more economical and effectual than any other.

We consider that of all the Fans designed for this purpose, the 'Blackman Air Propeller' or Exhaust Fan as illustrated on page 25 is the best in every respect for moving large volumes of air rapidly and silently, and at a very small cost for motive power.

We have also used these Fans most successfully for moving the air in drying rooms for evaporating moisture in various ways on a large commercial scale, and we can testify that they are unrivalled for the purposes mentioned.

For ordinary household or general use, however, we think it is advisable and much more simple and economical to keep the 'Heating' and 'Ventilation' separate, that is, to heat separately and ventilate separately, as follows:

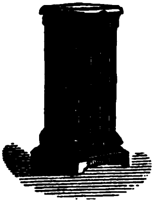
To heat an ordinary-sized one or two storey dwelling-house all that is required is simply to warm the main hall or lobby *thoroughly*, this being the main artery, as it were, of the house, admitting cold air from the outside, and plenty fresh or cold air generally finds its way into this hall in winter, without any special provision requiring to be made for the direct admission of fresh air from the outside.

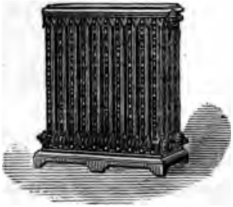
The simplest and best way to do this in ordinary small houses is to place a large coil of pipes, forming a square or oblong box or table, against one of the walls of the hall, on the floor, or in the well of staircase (if it is large enough, and if a two storey house) and connect this coil table, say below, by a flow *and return pipe to a small* boiler placed in the basement, and connected to any spare chimney there, the boiler requiring no building work, but standing on the basement floor next chimney like a stove—the whole being filled with water from a small supply cistern, placed at a little higher level than the top of the coil table in hall, in any convenient part of the house.

To be effective, of course the coil table must be of a fair size, having a great deal of heating surface in small space, in the form of pipes or other appliances, so that a little heat on a large heating surface will gently but amply warm the hall, and consequently the house, which the hall directly feeds with air.

The box coil mentioned, can be in the form of rows of pipes, say of two inch bore, closely jointed together, over which can be placed a metal coil case, with marble slab on top, forming to all appearance, when nicely painted, a handsome hall table or cabinet—no pipes being visible; or instead of a pipe box coil and coil case over it, as described, we would advise one of our new Ornamental Sectional Coil Tables to be used—which forms a handsome hall coil table complete in itself, without any coil case being required, no pipes being seen, and which can do with a smaller boiler to do the work, and has three times the radiating surface, in the same space, of any other form of pipe coil in use.

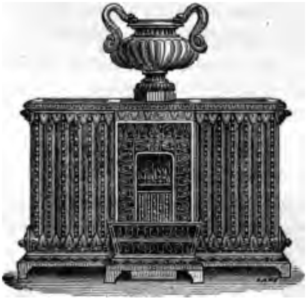
These new Sectional Coil Tables are constructed of ornamental vertical sections bolted together, no bolts or connecting pipes being seen, as illustrated, and they can be made any suitable length.





The aforesaid plan of heating is, of course, for a house with a basement or cellar floor, and which has no available chimney in the hall or lobby; but if the same style of house, having no basement or cellar floor, were to be heated, we would simply fit one of our boilers with a water base, or arrange it otherwise so that it could be safely set if necessary, on a wooden floor on same floor level as the coil in the hall; and. provided a chimney could be got handy, the boiler could then be connected to the coil direct on the level, even though some distance from it, or set in the hall alongside of coil if required.

If, again, a chimney were available in the hall or lobby, we would advise even a much simpler and equally effective arrangement, viz., to place one of our new Ornamental Open Fire Hot Water Apparatus in the hall and connect it direct to the chimney. The following illustration will at once show the form and principle of the apparatus, which of course requires neither boiler, pipes, nor special cistern, it being complete in itself, and forming an ornamental and powerful hot water heating apparatus, ready to be set down anywhere, on a wooden floor if necessary, no pipes or smoke pipe being seen.



This apparatus combines warmth, cheerfulness, ventilation, and perfect safety; is made in various sizes and designs, price from £26 upwards, and it can be put up or taken down rapidly; it is unrivalled as a powerful, efficient, safe, and healthy warmer.

In practice we find that either of these plans in small houses, with a small fire in the principal living room (to give a cheerful appearance, and help to draw in the warm air from the hall) gives general satisfaction, without any separate or *direct* inward or outward ventilation being required, or without fires being necessary in the bedrooms; and that a genial and healthy warmth pervades the whole house.

In either case, if separate ventilation is essential, we make the base, of either the coil table or the open fire hot water apparatus described, close, all round down to floor, and simply draw in cold air from the outside to underneath the coil in the hall, or ventilate the hall and rooms separately by upright air inlet tubes, carried above the head level, from the floor, and *outward* ventilate by the chimney fire-places, and into the same chimneys near the ceiling, by small self-acting flap ventilators inserted in the walls, which would then give perfect ventilation and perfect warmth without draughts.

It may be noted here that, though a room heated by an open fire be ever so warm, having a cold hall adjoining, a disagreeable cold draught is at once caused by the simple opening of the door from the cold hall into the warm room, the draught being towards the fire-place; while, again, if the hall is warm and the room cold, on the opening of the said door, if there is any draught felt at all, it is an agreeable and a warm one, which in a short time warms the room.

To heat larger houses, mansions, hotels, hydropathic establishments, and public institutions, &c., in most cases it is necessary to have separate 'Heating' and 'Ventilating' arrangements in main hall, and in each corridor and large public room in the different parts and floors, but all on the same principle as already described for smaller houses. Public halls, concert rooms, theatres, and churches, again, must be treated differently. In public halls and places of amusement especially, *separate*, *outward*, and *inward* 'ventilation' and *separate* 'heating' are indispensable, as these places to be perfect should be so planned and fitted that in a very short space of time either a warm or a cool healthy temperature can be secured without draughts.

No distinct plan, however, can be given here to effect this, as these buildings generally differ so much in structure and surroundings that it is necessary, in most cases, to plan out each by itself as to Heating and Ventilation, either from the plans of a proposed building, or on the spot for an existing building.

In regard to the heating of churches and schools, see separate article on 'Church and School Heating' further on.

In a lecture delivered to the members of the Edinburgh Philosophical Institution, in Queen Street Hall, Edinburgh, on 'Domestic Sanitation,' some time ago, Professor Fleeming Jenkin, in corroboration of what we advise, said:

'Passing to Warming and Ventilation, a healthy man 'accustomed to fresh air was a competent judge as to whether 'air was fit to breathe, and whether a draught was perceptible or 'not. But men of weak constitution and sedentary habits some- 'times acquired a preference for hot, close air, and felt the 'smallest breath of pure air as a draught. Still the ventilating 'engineer must provide for invalids as well as for healthy men, 'and contrive so as to give the hot-house plants their pure air 'without letting them know that they got it. The ideal 'condition of comfort and healthiness was that represented by a '*hillside on a still* spring morning, when the sun was shining

'brightly, and there was frost in the air. This ideal condition of
'ventilation and warming was consistent with a preference of
'open fires.'

And after enumerating the various modes of heating, and their effects, the Professor sums up as follows :—

'So long as any one could afford it, let him warm his *rooms*
'by open fires, and his *hall or lobby* by *warm water pipes*—only
'taking to *inferior* methods when he could not help himself.'

This system of Hot Water Heating, which we have advised and applied so successfully for years, is just in its infancy, and seems to be universal in its applications, and there is really no occasion why our houses and places of meeting, public or private, should not be so warmed, seeing it costs comparatively so very little to accomplish this.

Photographic establishments, studios, dwelling-houses, mansions, hotels, hydropathic establishments, conservatories, vineries, hot and drying rooms, colleges, schools, prisons, public halls, churches, warehouses, printing offices, shipping and other offices, shops, showrooms, workshops, factories, winter gardens, &c., &c., have been most successfully, healthily, and economically warmed by us in all parts of the country by our system of 'Hot Water Heating,' at a comparatively trifling cost for fuel per day, while the risk of *fire* has been reduced in these cases to a minimum.

CHURCH AND SCHOOL HEATING.

Public attention has lately been directed to the subject of Heating Churches and Schools, principally because of the absolute necessity of making these comfortable during winter, and in our damp, variable climate,—it having been most effectively shown of late years that the ordinary and old-fashioned clumsy modes of heating both churches and schools are of very little use when most wanted, and that they are, besides, most expensive in fuel, dangerous from fire, and very unhealthy when in use.

Ordinary open fires, stoves of all sorts, hot air appliances, steam heating, high pressure or small pipe hot water system, and the old-fashioned ordinary hot water heating, have been the principal modes in use hitherto, and they are all utterly unsuitable for church and school heating,—either on the score of inefficiency, unhealthiness, danger from fire or explosion, or expense for fuel.

Hot Water Heating, by the circulation of **hot water** (as is now universally acknowledged by medical men), is the only healthy heat obtainable by artificial means, the air (as we have already shown) being simply *warmed* without being *scorched;* it is consequently the only heat advisable for introduction wherever health is a consideration,—only, for churches and schools, it has to be *specially* applied to be suitable and economical.

By the ordinary hot water mode Church and School Heating is too often a failure, owing to the inferior and imperfect way of fitting generally adopted, such as placing the heating pipes wholly beneath the passages or floors, under gratings, in stone or brick heat-absorbing trenches, and not at the same time allowing for sufficient pipe surface to overcome the loss; together with the use of old-fashioned built-in saddle boilers, or such like, of slow circulating power,—which all help to make this ordinary way of hot water heating so slow in action and so expensive for fuel as to make it almost useless for churches and schools.

We have directed special attention to this subject (which is now one of our well-known specialties), and have consequently *succeeded in showing*, by practical application, that our System of Heating by Hot Water, as specially applied by us to many churches and schools, is the only proper, economical, healthy, efficient, and safe mode.

Churches, especially, having necessarily to be heated up rapidly once a week, say on a Sunday morning, the Apparatus must be properly and scientifically constructed, as well as most powerful, in order to accomplish the heating rapidly, economically, and satisfactorily, and overcome draughts consequent on quick heating.

It will thus be seen that the radiating surface inside the Church or School cannot be too great, nor the circulation of hot water through the pipes too rapid, as the greater the amount of heating surface in pipes or other appliances, and the more powerful or larger the boiler used, the more quickly will the heat be raised and kept at a uniform temperature, with less attention and at a less cost for fuel; the explanation of this being, that the larger number of pipes, having a greater radiating surface, less heat is required on them to give the same result; thus, the fire of the more powerful or larger boiler can be worked, rested, or damped down nearly all the time after the pipes are once hot. This also ensures better results, as the air is heated more gently and equally than if the heating surface were less and its temperature higher.

First cost should not, therefore, be so much considered in this class of work,—as hot water heating, being generally done once for all, if not well and properly done to begin with, is better not to be done at all,—as a cheap and inefficient appliance invariably turns out to be dear at any price in the long run.

Our System of Heating embodies all these sound principles, and our Patent Boilers for heating and circulating the water through the pipes are unrivalled as 'rapid circulators and fuel economisers'; and they requre no brick or building work round them, being all 'water jacketted,' and constructed on an entirely new principle, as already fully explained.

Owing, therefore, to the many advantages of our Patent Boilers and System of Heating over all other modes, we are enabled to guarantee the thorough warming of Churches and Schools in coldest weather for a mere trifle for fuel per diem; the cost of fuel per Sunday for a Church, averaging not more than half-a-crown, in many small churches much less,—two or three hours' time in winter, on a Sunday morning, being all that is required to raise the heat, say to 60°.

We will be pleased to take in hand to heat either new or existing churches or schools non-heated, or those badly or expensively heated at present, giving our guarantee in every case that we will be successful.

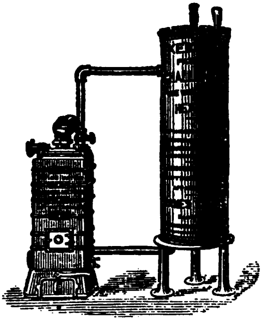
In all cases the 'Heating' and 'Ventilation' of Churches should be *separate.*

HEATING OF WATER.

The heating of water by *circulation*, for Washing and Bathing purposes, is, if proper appliances are used, the most efficient and economical plan possible.

As already explained under 'Steam Heating,' unless for special boiling purposes, or under peculiar circumstances, or for the heating of salt water, or when the result cannot possibly be attained by circulation (which is rare), the heating of water in volume by 'hot water circulation' by powerful but economical boilers, is the only economical and sure mode of obtaining satisfactory results.

Our Sectional Challenge Boilers when fitted up and connected to large galvanized iron cylinders in the manner illustrated, give clean hot water continuously, in any quantity and to any height necessary, within a few degrees of boiling point, for bathing or washing or manufacturing or other purposes, free from rust, at a mere fraction of the cost that it can be got for by any other means.



In connection with this, it may be mentioned that the Committee of the International Health Exhibition, South Kensington, 1884, selected Keith's Patent Hot Water Apparatus, as explained and illustrated, but specially designed for the purpose, for the continuous hot water supply to the Dairies during the Exhibition.

Also we have a 'Pure Water Heater' appliance, which can be attached to any existing hot water heating Boiler in a similar manner, which gives *pure* and *clean* hot water or other liquid, drawn directly through the 'Heater' from the water main or cistern, without the water having to pass through the boiler or the iron circulating pipes at all; and this can be kept going in summer equally well by the same heating apparatus with all the heating or warming pipes shut off the building.

We have also lately adapted some of our largest 'Challenge' Boilers for the circulation of water round gasholders in winter to prevent freezing, by keeping up a constant moving current of tepid water round and round gasholders on surface of water in water tanks; particular mention may be made of this having been done in the case of the large gasholder water tanks of the Dundee Gas Works Corporation, one of these being over 150 feet in diameter, and of which, Mr John M. M'Crae, the gas manager, writes in the following terms:—'The application of the "Challenge" boiler for the purpose of keeping gas tanks from freezing, is in my opinion a good one, and no process in my experience is so neat, effectual, and complete.'

The same principle has been most economically and efficiently applied for keeping the water in large enclosed swimming baths at a mild or warm temperature without the slightest noise. The blowing of live steam into the water (which is the only other mode in use for this purpose) even though made noiseless is most expensive for fuel and tear and wear, and, being generally applied intermittently, the heating of the water is most variable and uncertain.

To raise the temperature of these large volumes of water, however, by *circulation*, most *powerful* and *rapid* circulating Boilers are required, and it is only because our 'Challenge' Boilers have these recommendations that the results mentioned can be accomplished.

There is no reason, if actually necessary, why a small, bright and cheerful-looking fire of anthracite coal should not be retained in every house, or, in fact, a small open fire in every room, if properly arranged, only at the same time every dwelling, rich or poor, should be thoroughly and healthily warmed throughout by a proper slow combustion Hot Water Apparatus in the basement, heated by anthracite coal, or coke, which would utilise nearly the whole of the fuel, instead of allowing nine-tenths of it to escape. and be an effectual guarantee against risk by fire and nuisance from smoke.

It is highly probable that in a short time *all* buildings will be properly, economically, and healthily warmed by this method, and the old open fire, or stove system, with all its attendant risks, entirely superseded ; but considerable pressure requires to be employed to overcome the determined conservatism of the British character in this particular, even in the face of the enormous destruction of valuable property and lives annually entailed by the use of the recognised system; it being also distinctly kept in view that the present system of using soft coal in open fires and stoves is one of the main causes of the smoke nuisance and periodical black fogs in our large cities, consequently it is extremely deleterious to health, and involves terrible waste of coal, as well as great and unnecessary labour, besides adding to the cost of insurance policies very materially.

We have also the authority of several medical men of high standing for saying, that if our homes were properly and healthily warmed and ventilated on the principles we advocate, there would be no necessity for invalids, and especially those afflicted with diseases of the chest and pulmonary organs, going abroad to avoid the winter and spring months, which are so particularly trying to delicate people in this country; as, by remaining in their own comfortable homes, thus treated, in a mild and equable atmosphere, they have the advantages of a warmer climate without the attendant risks of fatigue, draughts, and chills, while travelling.

We hope these remarks will be conducive to much good in this matter of heating and ventilating, and that they will help the early solution of it and the smoke abatement question, to which so much attention has been drawn of late. We may only add that we shall have great pleasure in planning and advising with our patrons in all parts, on being communicated with; our experience and success in this particular line in the past being the best guarantee we can give of the soundness of our views on the matter.

SCIENTIFIC IMPROVEMENTS.

I.—ECONOMICAL HEATING.

An Editorial Article which appeared in the 'Evening Telegraph,' Dundee, March 22, 1878. By John Leng, Esq., Editor of the 'Dundee Advertiser.' The Article was illustrated by Woodcuts of Boilers.

We purpose to devote a column or two from time to time in order to bring under the notice of the public scientific inventions, more especially when the inventors reside and have their works in this district. We begin to-day with a notice of the scientific methods of heating practised by Mr James Keith, gas and water engineer, Arbroath. This is a subject in which everybody is more or less directly interested, for, although coals are cheaper again than they were, the probability is that whenever trade revives they will again advance in price; but even the present depression of trade makes the economical use of coals more important, as, when profits were large, it was comparatively unimportant what coals cost, and now the saving on the consumption of coals may —as in the case of steam vessels since the introduction of compound engines—make all the difference between a profit and a loss. There is no doubt that the original cheapness of coals led to the most extravagant and wasteful use of fuel in this country. For domestic purposes especially, until of late, our stoves and fireplaces were constructed so as to give the least possible heat from the greatest possible consumption of coal. The writer of these lines has for the last twenty years given his attention to the subject of heating, and has tried numerous experiments at his own cost, having no more interest in one invention than another. Our experiments have been both in the heating of houses, conservatories, and public offices by gas, steam, and water. Our experience, speaking generally, is adverse both to gas and steam. Gas is costly and inefficient; steam is scorching and difficult to regulate. Both are quite unsuitable for houses, churches, public buildings, and conservatories. Although we have not ourselves tried hot air, we have examined several contrivances of that kind, and not been favourably impressed by them. Our verdict is decidedly in favour of mild warm-water heating, with large pipes and small boiler so arranged as to give rapid circulation. There are some systems which have small pipes and large boilers. In these the water becomes superheated, and the heat given off by the pipes has the same scorching character as if steam were used. That is objectionable. The best plan is by using large pipes to have abundant radiating surface for a gentle degree of heat. In public buildings, churches, warehouses, offices, shops, &c., it is much more economical to have the pipes exposed at or above the floor level. If they are sunk below the floor, or recessed or covered up, more or less of the heat is lost. When quite open all the heat radiated is serviceable. These remarks apply to all systems alike.

Assuming that the pipes are of the right diameter—three or four (we prefer four) inches—and rightly placed, without dips, and all gradually ascending to the expansion cistern, the fundamental, and by far the most important, question is, what kind of boiler shall be used? There are a great many kinds. Scores of different boilers have been planned for heating purposes. What is known as the saddle boiler is generally preferred. There are different varieties—some of them double. The general idea is to have the boiler arch over the fire bars, and by flues to carry the flames and heat round and over as well as under the boiler, so as to extract as much heat as possible from the fire. Some succeed better than others, but almost all of them are subject to great loss of heat from the top of the boiler and the sides becoming coated with soot, which, being a non-conductor, prevents the fire coming in direct contact with the boiler. No doubt, by constant attention the flues might generally be kept pretty clear of soot, but constant attention is precisely what is next to impossible to secure. To be thoroughly efficient a boiler should be so constructed as to make sooting-up impossible. This is what Mr Keith claims for his boiler, along with such arrangements as convey to the pipes the greatest proportion of heat from the fires. But the greatest fault of the saddle or other boilers of this class is that there is no rapid or internal circulation in these forms of boilers independent of the pipes. These boilers being simply, as it were, an enlarged continuation of the pipes over the fire, in which the water can simply heat and pass slowly off through the pipes, only to return again nearly cold, the circulation is sluggish throughout. This means, of course, great waste of fuel with very little comparative heat given off. Mr Keith's boilers, again, are on quite a different principle, as he causes a rapid internal circulation inside his boilers by his patented method; and his boilers in this respect seem to have the same comparative results to the old-fashioned saddle boiler as the most improved flue steam boiler filled with Galloway tubes has to an old-fashioned pot or egg-end steam boiler. Mr Keith began his education as a water engineer in America and Canada, where he studied the different methods of heating, the severe winters there having long exercised American ingenuity in heating before attention was directed to the subject on this side of the Atlantic as fully as it has been recently. He considers that he has improved on even the best American modes of heating, and the fact that a large demand has sprung up for his boilers in America speaks well for their success.

Our attention was first directed to Mr Keith's method by learning of its application in the large establishment of Mr Valentine, photographer, Perth Road, where there were formerly four large stoves and an open fireplace, all which together failed to give the requisite heat with the evenness and regularity desired. The following is Mr Valentine's own report on the result of adopting Mr Keith's system:—

'I have at last got heat to my satisfaction. Not a hitch in 'its operations since its introduction has taken place. Little 'attention is required, it being only fed once a day, and at a 'cost of less than two shillings per week. I use gas coke, 'although the cheapest coal dross may, with equal advantage, 'be used. I am now, in the coldest weather, in a comfortable 'atmosphere, every part of my large premises being uniform in 'temperature, besides having an abundant supply of hot water 'for washing. In an hour after the fire is lighted a mild and 'healthy temperature pervades the whole place. I have said 'a "mild heat," but a great heat can be secured; only open the 'damper, give more draught, and shortly afterwards you will 'feel as if in an oven. The freedom from dust is a not less 'important consideration; for, except a small quantity of dust 'which falls into the ash-pan, there are no ashes—all are con-

'sumed with the smoke, and the ashes that may fall through the 'grate bars have only to be taken from the ash-pan and placed 'in the fire with fresh fuel, when they will be burned over again 'into dust.

'Over the pipes and at the boiler I dry my albumenised 'silver paper, and from a galvanized hot water tank, most 'ingeniously fitted to the higher part of the apparatus, I can 'draw in my washing troughs an unlimited supply of hot water— 'so valuable in a printing establishment. This hot water tank 'is also so directly arranged and connected to the boiler by 'separate pipes and stop-valves that I can still get the hot 'water for washing in the summer time without having to 'heat up any other part of my premises, all the rest of the pipes 'for heating being shut off in summer.

'As the apparatus requires only to be supplied with fuel once 'or twice a day, according to circumstances, it can go on night 'and day, thus ensuring at all times an equal temperature. At 'night the fire is simply filled with ashes and fresh fuel, and 'every inlet and outlet to the fire being closed by suitable 'appliances attached to the apparatus, the whole is perfectly 'safe and free from risk of fire. The fire of the boiler being all 'water "jacketted" or surrounded on the outside wholly by 'water, the premium for fire insurance is thus reduced to a 'minimum.

'The piping I have is about three inches in diameter, and of 'cast iron; but I believe Mr Keith uses various sizes of pipes to 'suit the different circumstances under which his system is 'introduced. He seems to fit up these pipes so as to produce 'perfect success.'

At our request two practical men inspected the apparatus in *Mr* Valentine's establishment, and expressed themselves highly satisfied with it. We then resolved to try one of Mr Keith's Boilers in the place of the saddle boiler we had hitherto used for a propagating house and conservatory, and the gardener who has charge of it is emphatic in his commendation on the two grounds of (1) rapid heating, and (2) small consumption of fuel. The quickness with which the heat can be raised, and the ease with which it can be maintained, are very remarkable. Instead of needing coal as with the saddle boiler, gas coke now yields ample heat, the saving in expense being very considerable. It may be explained that, differing from the saddle and other boilers, Keith's is not set in brickwork, so that there is no loss of heat by the absorption of the bricks.

An idea of the action of the boiler may be formed when we state that the circumference of the upright boiler is a double shell, the space between the external and the internal shell being filled with water. The fire is thus in close and constant contact with the boiler. Besides this there is an internal shell or circulating heater, which, according to Mr Keith's explanation, is 'perforated or otherwise, and placed inside the fire-box of internal ring shell, and which, being connected to the top and bottom of outside water ring, causes an excessive circulation through every part of the boiler itself.' In fact this internal circulation mentioned seems to be the great secret of the success of this boiler, as a rapid circulation being continually kept up inside of the boiler by this novel 'heater,' a corresponding quick circulation is communicated to the pipes, which is attested by the return pipe soon becoming and remaining almost as hot as the flow pipe.

Mr Keith has about a dozen different sizes and forms of boilers —smaller ones for heating by paraffin, gas, coal, or coke, and much larger ones for churches and extensive buildings, in some of which the arrangement is more complex, but in all the principle is the same—a thin body of water surrounding or surrounded by (as in the internal heater arrangement) the fire, so as to extract the heat in a way to promote rapid internal circulation. For churches and public buildings it is important to get up the heat quickly, although the secret of having all such places comfortably heated is to have them thoroughly warmed some hours before they need to be used, otherwise the warm air becomes refrigerated on the cold walls and cold draughts are caused, which are almost worse than if no attempt at heating were made. In churches the heat should always be raised on Saturday, and the fire then damped down. We certainly regard Mr Keith's apparatus as very successful, based on right principles, and showing great ingenuity in achieving rapid heating with a small consumption of fuel.

ECONOMICAL HEATING.

When the first portion of the *Dundee Advertiser* Office was built in Bank Street nearly twenty years ago it was fitted up with warm water heating apparatus, which was gradually extended along with the extension of the building. But when the large printing-room was erected over the whole of the main building it was considered that the original boiler would be overtaxed, and it was therefore resolved to heat it up by steam. The warm water apparatus was satisfactory from the first, but the heating by steam was always more or less objectionable—the heat from the steam pipe being too swift and strong, burning the air, and being apt to cause an unpleasant feeling, headaches, &c. It was also troublesome on account of the condensation of water in the pipes. The original boiler for the heating apparatus having shown some signs of decay, it was recently resolved to obtain a new one, and to convert the steam pipes into water pipes. Having had a couple of years' experience of Keith's patent boiler applied to conservatories, and having found it remarkably economical in the consumption of fuel, the work was placed in Mr Keith's hands, and we have much pleasure in testifying to the perfect success with which the whole office is now kept at a genial temperature at an exceedingly small expense. Having to heat about 1000 feet of pipes, we adopted one of the No. 9 boilers, which, while being more powerful than the one it displaced, occupies less room, has no brick work connected with it, and burns much less fuel. The fire may be said to be entirely surrounded by the water which requires to be heated, and the arrangements are such that, as nearly as possible, all the heat from the fire is abstracted by the water. Our experience during the recent cold weather has been that a single bag of gas coke per day heats the whole of the publishing, editorial, and printing departments of the *Advertiser* Office. Without such apparatus we should need about twenty fires, consuming several shillings' worth of coals daily, and requiring considerable attention in supplying the different rooms with coal. As most people know, it is not easy to regulate the fires in large offices, as they are often too hot in warm weather and neglected in cold. It is a great advantage to have rooms comfortably warmed without needing any personal attention, and without any trouble from smoke or dust. A still greater advantage is the moderate, equable summer temperature which can be maintained throughout the winter. As the water is not heated above 100 degrees, there is no smell of hot iron from the pipes, and not the slightest tendency to headache is felt. We have no hesitation in saying that for public offices and public buildings generally, Keith's system of heating is admirably efficient and economical.—*Extract from 'Dundee Advertiser,' of date Friday, 17th October* 1879.

From 'DUNDEE ADVERTISER,' *of 17th January 1882.*

Of all the systems of hot water heating, none gives results so satisfactory as Mr Keith's. The boilers designed by him are simple and yet effective in abstracting the great part of the heat of the fuel they burn.

From the 'BRADFORD OBSERVER' *of 25th February 1882.*

After making numerous inquiries as to some of the best known systems of heating, and into the relative merits of hot air, high pressure and low pressure, hot water, saddle, tubular, and other boilers, it was determined to engage Mr James Keith, of Edinburgh and Arbroath, to heat the *Bradford Observer* Office. That gentleman has carried out the wishes of the proprietors in a manner which leaves little to be desired. In a large establishment like this, nearly all the departments of which are at high pressure night and day, it is, of course, absolutely necessary that there should be as little friction as possible, and the expedition with which a considerable amount of complicated and tedious work was got through, was remarkable. Each floor is heated by an entirely separate system of pipes fitted with cut-off valves, so that any floor can be heated or otherwise at pleasure, without interfering in any degree with the others. During the coldest weather of this winter, not the slightest difficulty occurred in keeping the Office thoroughly warmed. Mr Keith's Boiler, which is not only exceedingly powerful but very economical, has been adopted for heating the new Technical School. Mr Isaac Holden also employs Mr Keith's boilers for his immense winter garden at *Oakworth.*

JAMES KEITH,

Gas, Hydraulic, Ventilating, and Heating Engineer,

LONDON, EDINBURGH, AND ARBROATH.

[Established 1823.]

KEITH'S PATENTS AND SPECIALTIES.

MINERAL OIL GAS WORKS for Lighting or Power Purposes.

HYDRAULIC RAMS, Self-Acting, for Raising Water.

HYDRAULIC RAM PUMPS, Self-Acting, for Raising Pure Water by Impure.

COUNTRY AND HOUSEHOLD WATER SUPPLY.

"CHALLENGE" HOT WATER BOILERS.

CIRCULAR HOT WATER BOILERS.

PORTABLE BOILERS AND HEATING APPARATUS.

SYSTEM OF HEATING AND VENTILATING.

ORNAMENTAL SECTIONAL STEAM AND HOT WATER COIL TABLES.

ORNAMENTAL OPEN FIRE HOT WATER HEATING APPARATUS.

VINERY AND GREENHOUSE HEATING.

STEAM HEATING for Drying Rooms, Turkish Baths, &c.

"CHALLENGE" PURE WATER OR LIQUID HEATERS.

HEATING OF WATER for Manufacturing, Bathing, and Washing Purposes.

HIGHEST AWARDS WHEREVER EXHIBITED.

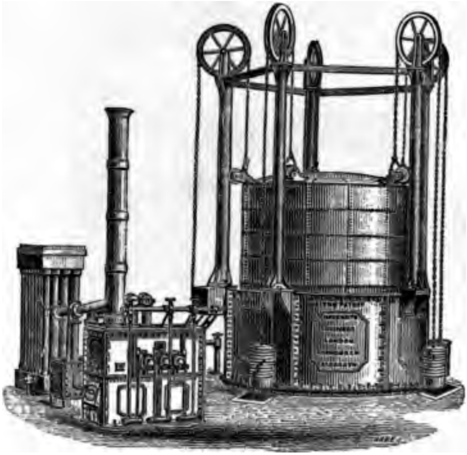
Awarded Lately, Three "First-Class Medals" and "Certificates," and "Honourable Mention," by the Philosophical Society of Glasgow; "The Medal" for Best Boilers by the Sanitary Institute of Great Britain.

KEITH'S PATENT

MINERAL OIL GAS WORKS,

UNRIVALLED FOR

Lighting Mansions, &c., in the Country.



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